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Artificial Intelligence Technical Paper Abstracts 1990

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Information Technology Division

and

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October 5, 1991

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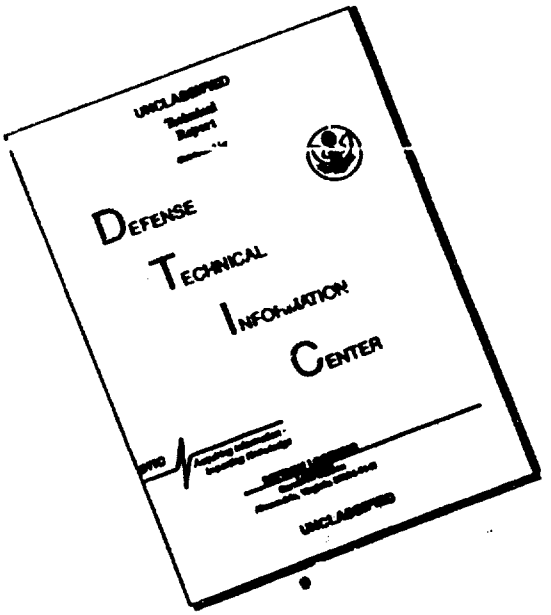

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13. ABSTRACT (Maximum 200 words)

"Artificial Intelligence Technical Paper Abstracts 1990" documents the accomplishment of projects at the Navy Center for Applied Research in Artificial Intelligence (NCARAI) in machine learning, natural language understanding, intelligent decision aids, and intelligent systems for robotic sensing and control. Points of contact are indicated for acquiring additional technical information about the projects, and an order form is provided for obtaining copies of the publications abstracted. This publication will be updated annually.

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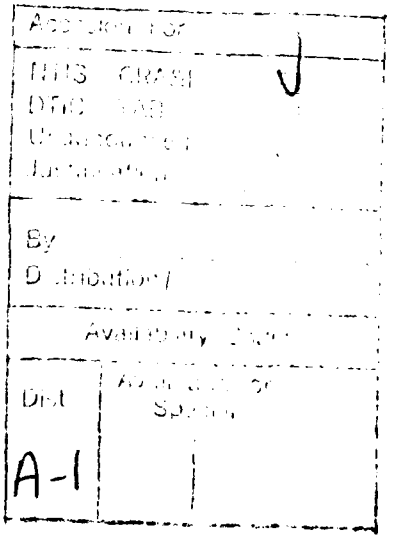

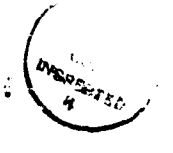

ARTIFICIAL INTELLIGENCE
TECHNICAL PAPER ABSTRACT
1990

Introduction

The Navy Center for Applied Research in Artificial Intelligence (NCARAI) is part of the Information Technology Division within the Naval Research Laboratory (NRL). NCARAI is engaged in research and development efforts designed to address the application of artificial intelligence (AI) technology and techniques to critical Navy and national problems. The emphasis at NCARAI is the linkage of theory and application in demonstration projects that use a full spectrum of AI methods.

The technical papers and reports of NCARAI document the accomplishments of projects in machine learning, natural language understanding, intelligent decision aids, and intelligent systems for robotic sensing and control. Innovative basic and exploratory research in these areas is made possible by NCARAI's staff of 35 individuals comprising an extraordinary cross section of AI talent from the government civilian and military sectors, visiting scientists from universities, and consulting scientists from industry. An ongoing seminar series, featuring notable scientists from academic and industrial research communities, as well as the military services, provides an excellent opportunity to exchange information and maintain awareness of current developments.

Persons interested in acquiring additional information about the reported results are encouraged to contact the relevant technical personnel for whom e-mail addresses have been provided.

Manuscript approved August 9, 1991

MACHINE LEARNING

Title: An investigation into the use of hypermutation as an adaptive operator in genetic algorithms having continuous, time-dependent nonstationary environments
Author(s): Helen G. Cobb
E-mail Address: cobb@aic.nrl.navy.mil
Technical Report citation: NRL Memorandum Report 6760, December 11, 1990
AIC Report No.: AIC-90-001

Abstract

Previous studies of Genetic Algorithm (GA) optimization in nonstationary environments focus on discontinuous, Markovian switching environments. This study introduces the problem of GA optimization in continuous, nonstationary environments where the state of the environment is a function of time. The objective of the GA in such an environment is to select a sequence of values over time that minimize, or maximize, the time-average of the environmental evaluations. In this preliminary study, we explore the use of mutation as a control strategy for having the GA increase or maintain the time-averaged best-of-generation performance. Given this context, the paper presents a set of short experiments using a simple, unimodal function. Each generation, the domain value mapping into the optimum changes so that the movement follows a sinusoidal path. In one of the experiments, we demonstrate the use of a simple adaptive mutation operator. During periods where the time-averaged best performance of the GA worsens, the GA enters hypermutation (a large increase in mutation); otherwise, the GA maintains a low level of mutation. This adaptive mutation control strategy effectively permits the GA to accommodate changes in the environment, while also permitting the GA to perform global optimization during periods of environmental stationarity.

Title: Genetic-Algorithm-Based Learning
Author(s): Kenneth A. De Jong
E-mail Address: dejong@aic.nrl.navy.mil
Book Chapter: Machine Learning Vol. III, Y. Kodratoff and R. Michalski (eds.), Chapter 21, pp. 611-638, 1990, Morgan-Kaufmann
AIC Report No.: AIC-90-002

Abstract

This chapter describes a subarea of machine learning that is actively exploring the use of genetic algorithms as the key element in the design of robust learning strategies. After characterizing the kinds of learning problems motivating this approach, a brief overview of genetic algorithms is presented. Three major approaches to using genetic algorithms for machine learning are described, and an example of their use in learning entire task programs is given. Finally, an assessment of the strengths and weaknesses of this approach to machine learning is provided.

Title: An Analysis of the Interacting Roles of Population Size and Crossover in Genetic Algorithms
Author(s): Kenneth A. De Jong and William M. Spears
E-mail Address: dejong@aic.nrl.navy.mil, spears@aic.nrl.navy.mil
Conference citation: First International Conference on Parallel Problem Solving from Nature, October 1-3, 1990, Dortmund, Germany, IEEE Society Press
AIC Report No.: AIC-90-003

Abstract

In this paper we present some theoretical and empirical results on the interacting roles of population size and crossover in genetic algorithms. We summarize recent theoretical results on the disruptive effect of two forms of multi-point crossover: n-point crossover and uniform crossover. We then show empirically that disruption analysis alone is not sufficient for selecting appropriate forms of crossover. However, by taking into account the interacting effects of population size and crossover, a general picture begins to emerge. The implications of these results on implementation issues and performance are discussed, and several directions for further research are suggested.

Title: Active bias adjustment for incremental, supervised concept learning
Author(s): Diana F. Gordon
E-mail Address: gordon@aic.nrl.navy.mil
Technical report citation: CS-TR-2464, UMIACS-TR-90-60, May 1990, University of Maryland
AIC Report No.: AIC-90-004

Abstract

This paper describes a new method for improving the performance of systems that learn concepts from examples. This method judiciously selects a language for expressing hypotheses, which are estimates of the concept being learned (i.e., the target concept). Experiments, described in this paper, demonstrate that the use of this method can lead to a significant improvement in the rate of convergence to the target concept.

Title: Explanations of empirically derived reactive plans
Author(s): Diana F. Gordon and John J. Grefenstette
E-mail Address: gordon@aic.nrl.navy.mil, gref@aic.nrl.navy.mil
Conference citation: Proceedings of the Seventh International Conference on Machine Learning, pp198-203, June 21-23, 1990, Morgan Kaufmann: Austin, TX
AIC Report No.: AIC-90-005

Abstract

Given an adequate simulation model of the task environment and payoff function that measures the quality of partially successful plans, competition-based heuristics such as genetic algorithms can develop high performance reactive rules for interesting sequential decision tasks. We have previously described an implemented system, called SAMUEL, for learning reactive plans and have shown that the system can successfully learn rules for a laboratory scale tactical problem. In this paper, we describe a method for deriving explanations to justify the success of such empirically derived rule sets. The method consists of inferring plausible subgoals and then explaining how the reactive rules trigger a sequence of actions (i.e., a strategy) to satisfy the subgoals.

Title: Genetic algorithms and their applications
Author(s): John J. Grefenstette
E-mail Address: gref@aic.nrl.navy.mil
Book citation: The Encyclopedia of Computer Science and Technology, Vol. 21, A. Kent and J. G. Williams (eds.),1990, New York: Marcel Dekker
AIC Report No.: AIC-90-006

Abstract

Genetic algorithms (GA's) are adaptive search techniques based on principles derived from natural population genetics. These algorithms have been used successfully in a variety of problems that require efficient heuristic search. This articles presents an overview of GA's, a discussion of the theoretical foundations and a review of recent applications.

Title: Strategy acquisition with genetic algorithms
Author(s): John J. Grefenstette
E-mail Address: gref@aic.nrl.navy.mil
Book citation: Handbook of Genetic Algorithms, L. Davis (ed.), Chapter 14, pp186-201, 1991, Van Nostrand Reinhold: Boston
AIC Report No.: AIC-90-007

Abstract

The growing interest in genetic algorithms can largely be attributed to the generality of the approach. Genetic algorithms can be used for both numerical parameters optimization and combinatorial search. This chapter shows an application to a rather different sort of problem: the optimization of policies for sequential decision tasks. In this approach, each policy, or strategy is represented as a set of condition/action rules. Each proposed strategy is evaluated on a simulation model of the sequential decision task, and a genetic algorithm is used to search for high-performance strategies. The approach has been implemented in a system called SAMUEL. This brief chapter should give the reader an idea of how genetic algorithms can be used to optimize strategies for this broad class of problems.

Title: Competition-based learning for reactive systems
Author(s): John J. Grefenstette
E-mail Address: gref@aic.nrl.navy.mil
Conference citation: 1990 DARPA Workshop on Innovative Approaches to Planning, Scheduling and Control, November 1990, pp348-353, Morgan Kaufmann: San Diego, CA
AIC Report No.: AIC-90-008

Abstract

Traditional AI planning methods often assume a well-modeled, predictable world. Such assumptions usually preclude the use of these methods in adversarial, multi-agent domains. This paper describes our investigation of machine learning methods to learn reactive plans for such domains, given access to simulation model. Particular emphasis is given to the task of assessing the effects of differences between the simulation model and the environment in which the learned plans will ultimately be tested. Methods for utilizing existing partial plans are also discussed.

Title: Conditions for Implicit Parallelism
Author(s): John J. Grefenstette
E-mail Address: gref@aic.nrl.navy.mil
Conference citation: Proceedings of the 1990 Workshop on Foundations of Genetic Algorithms, Morgan Kaufmann
AIC Report No.: AIC-90-009

Abstract

Many interesting varieties of genetic algorithms have been designed and implemented in the last fifteen years. One way to improve our understanding of genetic algorithms is to identify properties that are invariant across these seemingly different versions. This paper focuses on invariants across these genetic algorithms that differ along two dimensions: (1) the way user-defined objective function is mapped to a fitness measure, and (2) the way the fitness measure is used to assign offspring to parents. A gentic algorithm is called *admissible* if it meets what seem to be the weakest reasonable requirements along these dimensions. It is shown that any admissible genetic algorithm exhibits a form of implicit parallelism.

Title: Learning sequential decision rules using simulation models and competition
Author(s): John J. Grefenstette, Connie L. Ramsey and Alan C. Schultz
E-mail Address: gref@aic.nrl.navy.mil, ramsey@aic.nrl.navy.mil, schultz@aic.nrl.navy.mil
Journal citation: Machine Learning Vol. 5, No. 4, pp.355-381, October 1990, Kluwer Academic Publishers
AIC Report No.: AIC-90-010

Abstract

The problem of learning decision rules for sequential tasks is addressed, focusing on the problem of learning tactical decision rules from a simple flight simulator. The learning method relies on the notion of competition and employs genetic algorithms to search the space of decision policies. Several experiments are presented that address issues arising from differences between the simulation model on which learning occurs and the target environment on which the decision rules are ultimately tested.

Title: Simulation-assisted learning by competition: Effects of noise differences between training model and target environment
Author(s): Connie Loggia Ramsey, Alan C. Schultz and John J. Grefenstette
E-mail Address: ramsey@aic.nrl.navy.mil, schultz@aic.nrl.navy.mil, gref@aic.nrl.navy.mil
Conference citation: Proceedings of the Seventh International Conference on Machine Learning, pp.211-215 June 21-23, 1990, Morgan Kaufmann: Austin, TX,
AIC Report No.: AIC-90-011

Abstract

The problem of learning decision rules for sequential tasks is addressed, focusing on the problem of learning tactical plans from a simple flight simulator where a plane must avoid a missile. The learning method relies on the notion of competition and employs genetic algorithms to search the space of decision policies. Experiments are presented that address issues arising from differences between the simulation model on which learning occurs and the target environment on which the decision rules are ultimately tested. Specifically, either the model or the target environment may contain noise. These experiments examine the effect of learning tactical plans without noise and then testing the plans in a noisy environment, and the effect of learning plans in a noisy simulator and then testing the plans in a noise-free environment. Empirical results show that, while best results are obtained when the training model closely matches the target environment, using a training environment that is more noisy than the target environment is better than using using a training environment that has less noise than the target environment.

Title: Improving tactical plans with genetic algorithms
Author(s): Alan C. Schultz and John J. Grefenstette
E-mail Address: schultz@aic.nrl.navy.mil, gref@aic.nrl.navy.mil
Conference citation: Proceedings of IEEE Conference on Tools for Artificial Intelligence TAI '90, pp328-334, November 6-9, 1990, Herndon, VA, IEEE Society Press
AIC Report No.: AIC-90-012

Abstract

The problem of learning decision rules for sequential tasks is addressed, focusing on the problem of learning tactical plans from a simple flight simulator where a plane must avoid a missile. The learning method relies on the notion of competition and employs genetic algorithms to search the space of decision policies. In the research presented here, the use of available heuristic domain knowledge to initialize the population to produce better plans is investigated.

Title: Using neural networks and genetic algorithms as heuristics for NP-complete problems
Author(s): William M. Spears and Kenneth A. De Jong
E-mail Address: spears@aic.nrl.navy.mil, dejong@aic.nrl.navy.mil
Conference citation: International Joint Conference on Neural Networks, Vol. 1 pp.118-125, January 15-19, 1990, Washington D.C., Lawerence Erlbaum Publications
AIC Report No.: AIC-90-013

Abstract

Paradigms for using neural networks (NNs) and genetic algorithms (GAs) to heuristically solve boolean satisfiability (SAT) problems are presented. Since SAT is NP-Complete, any other NP-Complete problem can be transformed into an equivalent SAT problem in polynomial time, and solved via either paradigm. This technique is illustrated for Hamiltonian circuit (HC) problems.

Title: An Analysis of Multi-point Crossover
Author(s): William M. Spears and Kenneth A. De Jong
E-mail Address: spears@aic.nrl.navy.mil, dejong@aic.nrl.navy.mil
Conference citation: Proceedings of the Foundations of Genetic Algorithms Workshop, July 1990, Bloomington, IN, Morgan Kaufmann.
AIC Report No.: AIC-90-014

Abstract

In this paper we present some theoretical results on n-point and uniform crossover. This analysis extends the work from De Jong's thesis, which dealt with disruption of n-point crossover on 2nd order schemata. We present various extensions to this theory, including:

1) an analysis of the disruption of n-point crossover on kth order schemata;
2) the computation of tighter bounds on the disruption caused by n-point crossover, by handling cases where parents share critical allele values; and
3) an analysis of the disruption caused by uniform crossover on kth order schemata.

The implications of these results on implementation issues and performance are discussed, and several directions for further research are suggested.

Title: Using genetic algorithms for supervised concept learning
Author(s): William M. Spears and Kenneth A. De Jong
E-mail Address: spears@aic.nrl.navy.mil, dejong@aic.nrl.navy.mil
Conference citation: Proceedings of IEEE Conference on Tools for Artificial Intelligence TAI '90, Vol. I, pp335-341, November 6-9, 1990, Herndon, VA, IEEE Society Press
AIC Report No.: AIC-90-015

Abstract

Genetic Algorithms (GAs) have traditionally been used for non-symbolic learning tasks. In this paper we consider the application of a GA to a symbolic learning task, supervised concept learning from examples. A GA concept learner (GABL) is implemented that learns a concept from a set of positive and negative examples. GABL is run in a batch-incremental mode to facilitate comparison with an incremental concept learner, ID5R. Preliminary results support that, despite minimal system bias, GABL is an effective concept learner and is quite competitive with ID5R as the target concept increases in complexity.

INTELLIGENT DECISION AIDS

Title: Using Classifier Systems to Implement Distributed Representations
Author(s): Lashon B. Booker
E-mail Address: wiley@aic.nrl.navy.mil
Conference Citation: International Conference on Neural Networks, IJCNN-90-WASH-DC, Vol. I, pp39-42, January 15-19, 1990,Washington, DC, Lawerence Erlbaum Associates
AIC Report No.: AIC-90-016

Abstract

This paper shows how the distributed representation techniques used in neural networks and other connectionist systems have a natural counterpart in classifier systems. Eventually, this representational correspondence may have important practical implications for the parsimonious design of hybrid systems having both subsymbolic and symbolic capabilities.

Title: BaRT: A Bayesian Reasoning Tool for Knowledge Based Systems
Author(s): Lashon B. Booker, Naveen Hota, and Connie L. Ramsey
E-mail Address: ramsey@aic.nrl.navy.mil
Book Chapter: Uncertainity in Artificial Intelligence 5', M. Henrion, R.D. Shacter, L.N. Kanal, and J.F. Lemmer (eds.), pp271-282, 1990, Elsevier Science Publishers B.V.: North-Holland
AIC Report No.: AIC-90-017

Abstract

As the technology for building knowledge based systems has matured, important lessons have been learned about the relationship between architecture of a system and the nature of the problems it is intended to solve. We are implementing a knowledge engineering tool called BaRT that is designed with these lessons in mind. BaRT is a Bayesian reasoning tool that makes belief networks and other probabilistic techniques available to knowledge engineers building classificatory problem solvers. BaRT has already been used to develop a decision aid for classifying ship images, and it is currently being used to manage uncertainty in systems concerned with analyzing intelligence reports. This paper discusses how state-of-the-art probabilistic methods fit naturally into a knowledge based approach to classificatory problem solving, and describes the current capabilities of BaRT.

Title: A Real Time Control Strategy for Bayesian Belief Networks with Application to Ship Classification Problem Solving
Author(s): S.A. Musman, L.W. Chang, and L.B. Booker
E-mail Address: liwu@aic.nrl.navy.mil
Conference citation: Proceedings of IEEE Conference on Tools for Artificial Intelligence TAI '90, pp738-744, November 6-9, 1990, Herndon, VA, IEEE Society Press
AIC Report No.: AIC-90-018

Abstract

Many classification problems must be performed in a timely or time constrained manner. For this reason, the generation of control schemes which are capable of responding in real-time are fundamental to many applications. For our problem, that is ship classification, tactical scenarios often dictate the response time required from a system.

In this paper we discuss efficient ways to prioritize and gather evidence within belief networks. We also suggest ways in which we can structure our large problem into a series of small ones. This both re-defines much of our control strategy into the system structure and also localizes our run-time control issues into much smaller networks. The overall control strategy thus includes the combination of both of these methods. By combining them correctly we can reduce of the amount of dynamic computation required during run-time, and thus improve thee responsiveness of the system.

Title: Evidence Combination and Reasoning and Its Applications to Real-World Problem Solving
Author(s): L.W. Chang, and R.L. Kashyap
E-mail Address: liwu@aic.nrl.navy.mil
Conference citation: Proceedings of Sixth Conference on Uncertainity in Artificial Intelligence, pp370-377, July 27-29, 1990, Cambridge, MA, Sponsored by General Electric
AIC Report No.: AIC-90-019

Abstract

In this paper a new mathematical procedure is presented for combining different pieces of evidence which are represented in the interval form to reflect our knowledge about the truth of a hypothesis. Evidences may be correlated to each other (dependent evidences) or conflicting in supports (conflicting evidences). First, assuming independent evidences, we propose a methodology to construct combination rules which obey a set of essential properties. The method is based on a geometric model. We compare results obtained from Dempster-Shafer's rule and the proposed combination rules with both conflicting and non-conflicting data and show that the values generated by proposed combining rules are in tune with our intuition in both cases. Secondly, in the case that evidences are known to be dependent, we consider extensions of the rules derived for handling conflicting evidence. The performance of proposed rules are shown by different examples. The results show that the proposed rules reasonably make decision under dependent evidences.

Title: Study of Interval-Valued Belief Combination with Conflicting Evidence
Author(s): L.W. Chang, and R.L. Kashyap
E-mail Address: liwu@aic.nrl.navy.mil
Conference citation: Proceedings of IEEE Conference on Tools for Artificial Intelligence TAI '90, pp725-730, November 6-9, 1990, Herndon, VA, IEEE Society Press
AIC Report No.: AIC-90-020

Abstract

In this paper we present a new mathematical procedure for combining conflicting evidence which are represented in the interval form. We propose a methodology to construct combination rules which obey a set of essential properties. he method is based on geometric model. We compare results obtained from Dempster's, intervals Bayes and the proposed combination rule with both conflicting and non-conflicting data and show that the values generated by proposed combining rule are in tune with our intuition.

Title: Testing and Evaluation of Expert System Prototype: A Case Study
Author(s): Laura Davis and Jay Liebowitz
E-mail Address: davis@aic.nrl.navy.mil, jayl@aic.nrl.mil.navy
Journal citation: Information Age, Vol. 12, No. 2, pp75-82, April 1990, Butterworth Publishers
AIC Report No.: AIC-90-021

Abstract

Testing and evaluation of an expert system are critical parts of the expert system's life-cycle development. Often, the procedures and results of these processes are not well documented. This paper presents the preliminary testing and evaluation methods, observations, and results for an expert system called CESA. It is hoped that the study will help the knowledge engineer by serving as a documented example of testing and evaluation procedures.

Title: FIS: An AI-Based Fault Isolation System
Author(s): Kenneth A. De Jong, Frank Pipitone and William M. Spears
E-mail Address: dejong@aic.nrl.navy.mil, pipitone@aic.nrl.navy.mil, spears@aic.nrl.navy.mil
Conference citation: Proceedings Technologies Today and Tomorrow IEEE Southeastcon '90, Vol. 2, pp770-774, April 1-4, 1990, New Orleans, Louisiana, IEEE Society Press
AIC Report No.: AIC-90-022

Abstract

FIS, short for Fault Isolation System, is an ongoing research project at the Navy Center for Applied Research in Artificial Intelligence, a branch of the US Naval Research Laboratory. The focus of the work is model-based expert system shell capable of acquiring from a user a description of a piece of electronic equipment called a unit under test (UUT). This description is later used by FIS to perform such diagnostic functions as recommending the next "best" test to make on the UUT during a fault isolation sequence and estimating fault probabilities after each test is made. These and other capabilities make FIS a powerful tool which can be used in a variety of diagnostic settings, as discussed in section 1.2. FIS has been developed primarily with large scale analog hybrid electronic systems such as radar and sonar systems in mind, but is applicable at least in principle to any human-engineered system with discrete replaceable components.

FIS is written in LISP and has been under development for several years. Detailed descriptions of the FIS system can be found in 1.2.3.4. In this paper we provide an overview of the current system and describe some of its current application areas.

Title: Evaluation of L2 Systems Learners and Theory
Author(s): Henry Hamburger
E-mail Address: henryh@aic.nrl.navy.mil
Journal citation: CALL, Vol. 1, pp19-27, 1990, Intellect Publishing Co.
AIC Report No.: AIC-90-023

Abstract

Evaluation of CALL systems depends on the answers to a series of questions: What are our goals and priorities for language learning, and within them what is demanded of CALL? What other kinds of entities - video-tapes, human tutors, other software - do we implicitly or explicitly set up as standards of comparison for CALL? To what extent do we want the CALL system to fit with existing approaches and theories? Shall we evaluate a CALL system as a monolith or by module? I elaborate these questions with particular attention to intelligent tutoring systems, offer some partial answers, and show how systems, learners, and theories are all important objects of evaluation.

Title: Semantically Constrained Exploration and Heuristic Guidance
Author(s): Henry Hamburger and Akhtar Lodgher
E-mail Address: henryh@aic.nrl.navy.mil
Journal citation: Machine-Mediated Learning, Vol. 3, pp81-105, Taylor and Mentor Systems, Inc.
AIC Report No.: AIC-90-024

Abstract

Exploration can be an effective learning experience, if suitably constrained and guided. Moreover, it can provide this benefit for specifically targeted formal skills in the arithmetic curriculum. This paper presents two complementary techniques for promoting success in computer-based exploration environments. Semantic constraints on exploration cut out meaningless options, and heuristic guidance facilitates search on the basis of a heuristic function with both cognitive and problem-solving components. We have implemented an environment that permits semantically constrained exploration for subtraction, as well as a related environment that facilitates the transition to paper-and-pencil subtraction. The authors tested the system in individual hour-long sessions with more than twenty children in grades 1-3.

Title: CESA: An Expert Systems Application in Contracting
Author(s): Jay Liebowitz and Laura Davis
E-mail Address: jayl@aic.nrl.navy.mil, davis@aic.nrl.mil.navy
Book Chapter: Expert Systems Applications, Chapter 2, pp49-53, 1990, I.I.I.T. International
AIC Report No.: AIC-90-025

Abstract

This paper describes the development of CESA, an expert system for aiding in Defense research contracting. Contracting is a ripe area for expert system application. Laypersons, such as scientists or new contract specialists, typically have difficulties in understanding, synthesizing, and applying relevant rules and regulations in the procurement request generation process. CESA is designed to act as an advisory system for aiding in the pre-award phase of the contractural process.

Title: Using Expert Systems to Help the Contracting Officer Technical Representative: A Feasibility Study
Author(s): Jay Liebowitz, Laura Davis, and Wilson F. Harris
E-mail Address: jayl@aic.nrl.navy.mil, davis@aic.nrl.mil.navy, harris@aic.nrl.navy.mil
Book Chapter: Educational Technology, pp25-31, January 1990
AIC Report No.: AIC-90-026

Abstract

Throughout U.S. Government agencies there are Contracting Officer Technical Representatives (COTRs) who are in charge of monitoring contracts and solving technical problems relating to these contracts. COTRs are a diverse community ranging from physicists and chemists to engineers and computer scientists. Automated support, and in particular expert systems, might be one approach to aid the COTR in better executing his/her duties and responsibilities. This article takes a look at using expert systems to help the COTR, and also a selection methodology to decide upom the best COTR problem domain for expert system development.

Title: A Parallel Implementation of a Belief Maintenance System
Author(s): Connie Loggia Ramsey and Lashon B. Booker
E-mail Address: ramsey@aic.nrl.navy.mil
Conference Citation: Proceedings of the Fifth Annual AI Systems in Government Conference, pp180-186, May 6-11, 1990,Washington, DC, IEEE Society Press
AIC Report No.: AIC-90-027

Abstract

An algorithm to perform belief maintenance was implemented on the Butterfly Plus™ Parallel Processor. This algorithm, which handles reasoning with uncertainty, is used in a system called BaRT which performs classification problem solving. The belief maintenance scheme uses a network to represent the problem domain, where each node in the network represents a hypothesis of the domain. The belief updating scheme is inherently parallel; incoming evidence can be attached to any number of different nodes in the network, and the impact of the evidence can be propagated through the network in parallel. Results show that a substantial improvement in the processing speed of belief updating can be realized, especially in cases where a great del of evidence is entered into the system at one time.

Title: Expert Systems at the Navy Center for Applied Research in Artificial Intelligence
Author(s): Randall Shumaker and Laura Davis
E-mail Address: shumaker@itd.nrl.navy.mil, davis@aic.nrl.mil.navy
Journal citation: Expert Systems With Applications, Vol. 1, pp71-77, 1990, Pergamon Press
AIC Report No.: AIC-90-028

Abstract

The Naval Research Laboratory (NRL), Washington DC, began operation in 1923 in response to a suggestion by Thomas Alva Edison that "The government should maintain a great research laboratory...In this could be developed...all the techniques of military and naval progression without any great expense." NRL initially contained two research division: radio and sound. It now consists of 15 research divisions encompassing a very wide range of technical specialities. One of NRL's newest research groups is the Navy Center for Applied Research in Artificial Intelligence (NCARAI), where significant effort is being made to transition artificial intelligence technology out of the laboratory and into service. Many of the research projects conducted by NCARAI are producing expert systems technology directed at broad problems within the Navy. Several of these systems are now mature and the efforts made in selecting problem domains, development, packaging, and distribution may provide useful insights for others.

NATURAL LANGUAGE

Title: InterFIS: A Natural Language Interface to the Fault Isolation Shell
Author(s): Dennis Perzanowski and Brian Potter
E-mail Address: dennisp@aic.nrl.navy.mil
Conference citation: NRL Report 9299, December 31, 1990
AIC Report No.: AIC-90-029

Abstract

InterFIS is a natural language interface with an electronics troubleshooting expert system that is part of an expert system development tool called the Fault Isolation Shell (FIS). In this report we present a brief overview of one module of the expert system and then discuss the natural language input into an appropriate representation for the expert system. We also discuss our research approaches, their implications, and the questions raised by our work. We conclude with a brief discussion of what work is required for the future.

Title: Structural Domain Modeling for Understanding Equipment Failure Messages
Author(s): Kenneth Wauchope
E-mail Address: wauchope@aic.nrl.navy.mil
Conference citation: Proceedings of the IEEE Southeastcon '90, Vol. 1, pp188-193, New Orleans, Louisiana, April 1-4, 1990, IEEE Society Press
AIC Report No.: AIC-90-030

Abstract

The goal of natural language understanding computer systems is to analyze and make use of the information contained in English or other natural language discourse. Understanding texts that discuss complex pieces of equipment, such as Navy equipment failure reports (CASREPs), requires the possession not only of general knowledge about the types of objects and predicates in the domain, but also detailed knowledge about the particular equipment in question. This more expert level of knowledge is needed to dereference the names and descriptions of equipment referred to in the text, and to infer their causal relations and operational states when these are only implicitly expressed by the message writer. Knowing the structural configuration of the equipment is useful in both tasks, and a structural domain model can be extracted readily from equipment manuals and their accompanying parts lists, thus easing the "knowledge acquisition bottleneck" problem and making practical applications more feasible.

Title: A Tandem Semantic Interpreter for Incremental Parse Selection
Author(s): Kenneth Wauchope
E-mail Address: wauchope@aic.nrl.navy.mil
Tech Report citation: NRL Technical Report 9288, Washington, DC: Naval Research Laboratory, 1990.
AIC Report No.: AIC-90-031

Abstract

The report describes TINSEL (Tandem INterpreter for SELection), a clause-local semantic interpreter and selection component for use with a natural language parser. As the parser incrementally regularizes candidate phrasal constituents into syntactic operator-operand forms, it submits each form to a user-defined selection process for the application of sublanguage constraints on co-occurrence patterns of semantic word classes. Only those analyses that pass selection are added to the parser's working space for involvement in further search, which can often reduce total processing time considerably. TINSEL treats selection as the enforcement of predicate domain constraints during semantic interpretation, the composing of a data structure that represents the meaning of a natural language phrase in some suitable formalism. The interpreter runs in tandem with the parser, transforming each semantically valid operator-operand form submitted to it into a predicate-argument form based on a set of declarative predicate models provided by the user. The parser's regularization component then composes partial interpretations of parent nodes from the interpretations of their children. TINSEL also operates top-down and so can be applied post parse to the final output of the parser rather than interleaved with it.

SENSOR BASED SYSTEMS

Title: Calibration of a Stereo System with Small Relative Angles
Author(s): Behrooz Kamgar-Parsi and Roger D. Eastman
E-mail Address: kamgar@aic.nrl.navy.mil
Journal citation: Computer Vision, Graphics, and Image Processing, Vol. 51, pp1-19, 1990, Academic Press, Inc.
AIC Report No.: AIC-90-032

Abstract

Because of their relative ease in solving the correspondence problem, stereo systems without a relative rotation are popular. However, in practice, mechanical difficulties will lead to a small, unknown relative rotation between stereo cameras. In this paper we present an algorithm for the calibration of a stereo system with small relative angles in an uncontrolled environment. This algorithm has two advantages: (a) It is more accurate than the existing algorithms in the computer vision and photogrammetry literatures. (b) It provides useful insight into the problem of camera calibration and relative orientation. This is done by deriving explicit analytical solutions for the relative pan, tilt, and roll angles in terms of the world pan angle (gaze angle) and the coordinates of the feature points used in their computations. These solutions allow us a better understanding of the problem of calibration in general by providing us with the insight as to how errors due to quantization and uncertainty in the location of image centers affect the computation of rotation angles. It is shown that as the distance features points from the center of the image decreases, the error due to quantization in the relative pan angle increases quadratically, that of the relative roll angle increases linearly, while that of the tilt angle does not change appreciably. Likewise, it is shown that errors in the locations of principal points (image centers) do not affect the computation of relative pan and roll angles appreciably, whereas the impact on the relative tilt angles is significant. These findings are likely to be of use even when the relative rotation angles are not small. All of the analytical findings have been supported by extensive simulation.

NEURAL NETWORKS

Title: Clustering with Neural Networks
Author(s): Behzad Kamgar-Parsi, J.A. Gualtieri, J.E. Devaney, and Behrooz Kamgar-Parsi
E-mail Address: kamgar@aic.nrl.navy.mil
Journal citation: Biology Cybernetics, Vol. 63, pp201-208, 1990, Springer-Verlag
AIC Report No.: AIC-90-033

Abstract

Partitioning a set of N patterns in a d-dimensional metric space into K clusters - in a way that those in a given cluster are more similar to each other than the rest - is a problem of interest in many fields, such as, image analysis, taxonomy, astrophysics, etc. As there are approximately $K^N/K!$ possible ways of partitioning the patterns among K clusters, finding the best solution is beyond exhaustive search when N is large. We show that this problem, in spite of its exponential complexity, can be formulated as an optimization problem for which very good, but not necessarily optimal, solutions can be found by using a Hopfield model of neural networks. To obtain a very good solution, the network must start from many randomly selected initial states. The network is simulated on the MPP, a 128 x 128 SIMD array machine, where we use the massive parallelism not only in solving the differential equations that govern the evolution of the network, but also in starting the network from many initial states at once thus obtaining many solutions in one run. We achieve speedups of two to three orders of magnitude over serial implementations and the promise through Analog VLSI implementations of further speedups of three to six orders of magnitude.

Title: On Problem Solving with Hopfield Neural Networks
Author(s): Behzad Kamgar-Parsi and Behrooz Kamgar-Parsi
E-mail Address: kamgar@aic.nrl.navy.mil
Journal citation: Biological Cybernetics, Vol. 62, pp415-423, 1990, Springer-Verlag
AIC Report No.: AIC-90-034

Abstract

Hopfield and Tank have shown that neural networks can be used to solve certain computationally hard problems, in particular they studied the Traveling Salesman Problem (TSP). Based on network simulation results they conclude that analog VLSI neural nets can be promising in solving these problems. Recently, Wilson and Pawley presented the results of their simulations which contradict the original results and cast doubts on the usefulness of neural nets. In this paper we give the results of our simulation that clarify some of the discrepancies. We also investigate the scaling of TSP solutions found by neural nets as the size of the problem increases. Further, we consider the neural net solution of the Clustering Problem, also a computationally hard problem, and discuss the types of problems that appear to be well suited for a neural net approach.

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